6) OR function

Linear equation : $0.5x_1 + 0.5x_2 - 1.25 = 0$

Learning rate, $\alpha = 0.01$

Hard threshold function

new weight = old weight + α (Target - ~~prediction~~) x input
$h(x)$

As hard threshold

$\therefore 0.5x_1 + 0.5x_2 - 1.25 \geq 0$ then output = 1

$0.5x_1 + 0.5x_2 - 1.25 < 0$ then output = 0

OR

	x_1	x_2	Y
1)	0	0	0
2)	0	1	1
3)	1	0	1
4)	1	1	1

For 1st input

input = 0,0

output = 0 [target]

~~prediction~~ = $h(x) = 0$

$0.5 \times 0 + 0.5 \times 0 - 1.25$

$= -1.25 < 0$

So, $h(x) = 0$

No update

for 2nd input

input = 0, 1

output = 1 [target]

$u(x) = 0$

$0 \times 0.5 + 1 \times 0.5 - 1.25$

$= -0.75 < 0$

$u(x) = 0$

$\therefore$ new $weight_1 = 0.5 + 0.01(1-0) \times 0$

$= 0.5$

new $weight_2 = 0.5 + 0.01(1-0) \times 1$

$= 0.51$

eq: $0.5x_1 + 0.51x_2 - 1.25 = 0$

for third input

input = 1, 0

output = 1

$u(x) = 0$

$0.5 \times 1 + 0.51 \times 0 - 1.25$

$= -0.75 < 0$

$u(x) = 0$

new $weight_1 = 0.5 + 0.01(1-0) \times 1$

$= 0.51$

new $weight_2 = 0.51 + 0.01(1-0) \times 0$

$= 0.51$

eq: $0.51x_1 + 0.51x_2 - 1.25 = 0$

For 4th input

input = 1, 1
output = 1
$h(x) = 0$

~~0.51 × 0.5~~
$0.51 \times 1 + 0.5 \times 1 - 1.25$
$-0.23 < 0$
$h(x) = 0$

new weight$_1$ $= 0.51 + 0.01(1-0) \times 1$
$= 0.52$

new weight$_2$ $= 0.51 + 0.01(1-0) \times 1$
$= 0.52$

equation : $\boxed{0.52x_1 + 0.52x_2 - 1.25 = 0}$

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Sigmoid function

$$h_{\underline{w}}(x) = \frac{1}{1 + e^{-\underline{w} \cdot \underline{x}}}$$

Let $0.5 \geq$ class = 1

$0.5 <$ class = 0

new weight

$$w_i \leftarrow w_i + \alpha \left(y - h_{\underline{w}}(x)\right) \times h_{\underline{w}}(x) \times \left(1 - h_{\underline{w}}(x)\right) \times \text{input}$$

$$0.2x_1 + 0.5x_2 - 0.6 = 0$$

or

0	0	0
0	1	1
1	0	1
1	1	1

i) 0 target = 0

input = 0, 0

$0.2 \times 0 + 0.5 \times 0 - 0.6$

$= -0.6$

$h_{\underline{w}}(x) = \frac{1}{1 + e^{-0.6}} = 0.3 < 0.5$

$\therefore$ class = 0

target = class

no change.

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derivation of sigmoid function

$$\Delta w_i \propto \frac{\delta \text{Loss}}{\delta w_i} = \frac{\delta}{\delta w_i}\left(y - h_{\underline{w}}(x)\right)^2$$

$$= \frac{\delta}{\delta w_i}\left(y - h_{\underline{w}}(x)\right)^2$$

$$= 2\left(y - h_{\underline{w}}(x)\right) \cdot \frac{\delta}{\delta w_i}\left(y - h_{\underline{w}}(x)\right)$$

$$= 2\left(y - h_{\underline{w}}(x)\right)\left[\frac{\delta}{\delta w_i}(y) - \frac{\delta}{\delta w_i}\left(h_{\underline{w}}(x)\right)\right]$$

$$= 2\left(y - h_{\underline{w}}(x)\right)\left[0 - \frac{\delta}{\delta w_i}\frac{1}{1+e^{-\underline{w}\cdot x}}\right]$$

$$= -2\left(y - h_{\underline{w}}(x)\right) \times \frac{\delta}{\delta w_i}\left(\frac{1}{1+e^{-\underline{w}\cdot x}}\right)$$

$$= -2\left(y - h_{\underline{w}}(x)\right) \times \frac{1}{1+e^{-\underline{w}\cdot x}} \times \left(1 - \frac{1}{1+e^{-\underline{w}\cdot x}}\right) \times \frac{\delta}{\delta w_i}\left(\underline{w}\cdot x\right)$$

$$= -2\left(y - h_{\underline{w}}(x)\right) \times \frac{1}{1+e^{-\underline{w}\cdot x}} \times \left(1 - \frac{1}{1+e^{-\underline{w}\cdot x}}\right) \times x_i$$

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$$= 2\left(y - h_{w}(x)\right) \times h_{w}(x) \times \left(1 - h_{w}(x)\right) \times x_i$$

$$h_{w}(x) = \frac{1}{1+e^{x}}$$

Cinput